



Yellow Drum Machine

Written By: Frits Lyneborg

🔧 TOOLS:

- Computer (1)
Windows, Mac OS X, or Linux
- Cutting tools (1)
For wood and wire
- Fine-gauge steel wire (1)
To hold sticks to the motor shafts while epoxying
- Hot glue gun and glue sticks (5) (1)
- Lighter or heat gun (1)
- Screwdriver, small, Phillips (1)
For mounting motors
- Soldering/desoldering tools (1)

⚙️ PARTS:

- Picaxe-28X1 Starter Pack (USB) (1)
http://www.techsupplies.co.uk/epages/Store.sf/en_GB/?ObjectPath=/Shops/Store.TechSupplies/Products/AXE001U
- PICAXE 28X1 microcontroller in a 28pin project board (AXE 020 board, with both a Darlington output buffer, and a place for one L293D motor driver) and an AXE027 download/programming cable.
- Motor driver chips, L293D (2)
Jameco Part no. 1341966 - L293D
- Solarbotics GM10 pager gearmotors (4)
These can only turn some 40 degrees to one side, and some 50 to the other. And when they are powered off, they jump back to where they started, because of the little spring. They are also quite strong for their small size, and I use them to drive the 3 drum sticks, and to turn the robot's head. <http://www.solarbotics.com/products/gm10/>
- Sound recorder module (aka sampler board), 20-second (1)
such as item #PPM155 from [techsupplies.co.uk](http://www.techsupplies.co.uk), or #276-1323 from [radioshack.com](http://www.radioshack.com). The Tech Supplies module's buttons both have wire pairs you can connect to easily. With RadioShack or other modules, you'll have to solder a wire to button pads on the circuit board.
- Speaker, 2", 16Ω (1)
Jameco Part no. 1956590 or 99996
- Ultrasonic distance sensor (1)
Devantech SRF05
- Solarbotics Gear Motor and Tread Package, GM9 (143:1, 90° shaft) (1)
A kit with both geared motors and the original tracks can be found here: <http://www.solarbotics.com/products/gmtpkg/> (Option: 143:1 offset shaft)
- Flat wooden sticks (1)
such as paint stirrers, popsicle sticks, etc.
- Lightweight tubing or rod, fiberglass, carbon fiber, or hollow aluminum, about 1" (20cm) (1)

- Lightweight fiberglass rod, very thin, about 6" (15cm) (1)
for the "bass drum" (tail) and "snare drum" sticks
- Aluminum or other tubing, 1/4" (6.4mm) diameter x 4" (10cm) (1)
for front wheel axle. Use the same tubing as above or something heavier. I like to cut pieces from old radio antennas.
- Metal washers (4)
to fit over the axle
- Battery holder (long), 4xAA (2x2) (1)
- Female-to-female jumper wires (15)
Yellow is nice, to match your robot.
- Wire, stranded, 18-22 gauge, 3' (1)
- Header pins, male, snap-off (4)
- Heat-shrink tubing (1)
Choose colors to match your design.
- Cable ties, various sizes and colors (1)
- Rechargeable AA batteries, 1.2V (4)
These need to be 1.2V -- standard 1.5V alkalines might fry your robot.
- Epoxy, quick-setting (1)
- Adhesive tape, double-sided (1)
either foam or thin

SUMMARY

A couple of years ago I started getting into Picaxe microcontrollers, and I ordered a bunch of random components to experiment with. Turning these funny little spring-mounted motors on and off, I thought, Hmm — I could put a stick on that and let the microcontroller drum! This

mini sound-recorder board? Hey, if the robot is drumming, it could record itself and play a new beat with the first one in a loop. Oh, nice yellow tracks, a rangefinder — cool, it could move around and look for things to drum on.

Step 1 — Build the chassis.



- Assemble the Gear Motor and Tread set into 2 tracks with 20 links each. Put a wheel on each motor and solder a 4" (10cm) lead to each motor contact.
- Make a flat wood chassis about $5\frac{1}{2}'' \times 2\frac{1}{4}''$ (14cm×5.5cm); it should be a bit longer than the tracks. I cut flat sticks into 4 pieces and glued them together. You can also use more sticks, or a single piece of wood with a hole drilled in it for wires to pass through.
- Flip the chassis upside down and affix the motors flat to its rear underside with doublesided tape. Orient the motors so that the tracks will run parallel along the chassis without touching it or sticking past its rear or front edges. The motors themselves should sit at least $\frac{1}{2}''$ away from of the rear edge, to leave room for the GM10 "tail" motor. Reinforce the join with 2 applications of hot glue, letting it cool in between.

Step 2



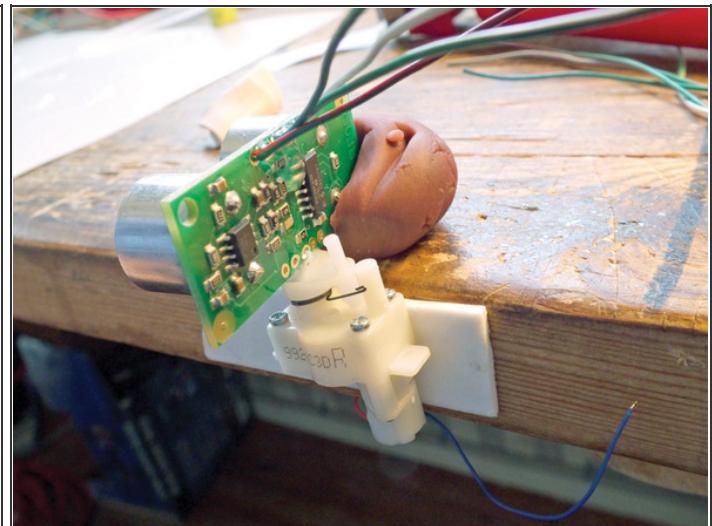
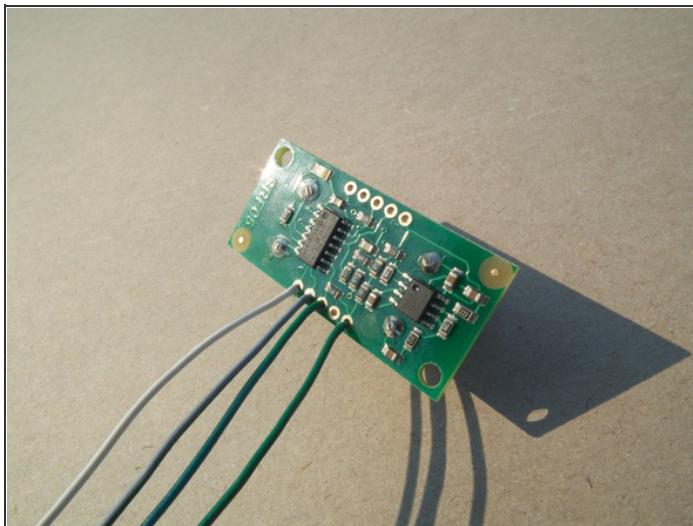
- Prepare your front axle so its wheels will turn freely without touching the chassis. I used 2 washers on each side to space the wheels away from the chassis, and a metal screw hot-glued into each end of the axle to keep the wheels from falling off.
- With the chassis still upside down, run the tracks around the wheel pairs. Push the axle forward (away from the motors) as you hotglue it to the bottom of the chassis. Try to get the tracks tight. The chassis will be tilted forward — that's fine.

Step 3



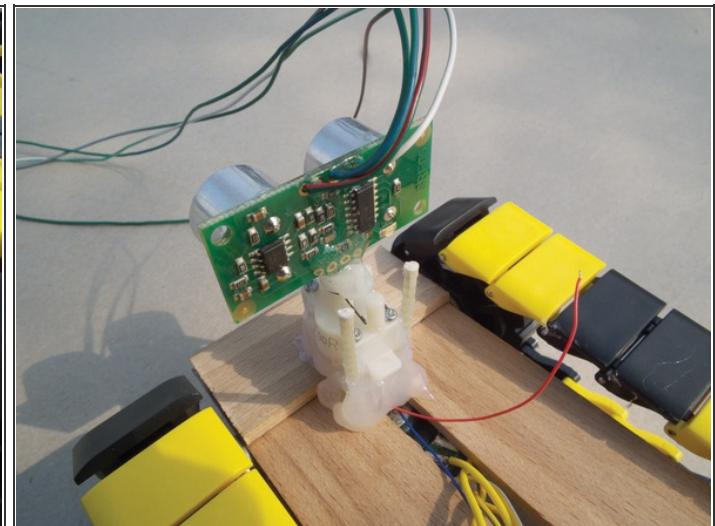
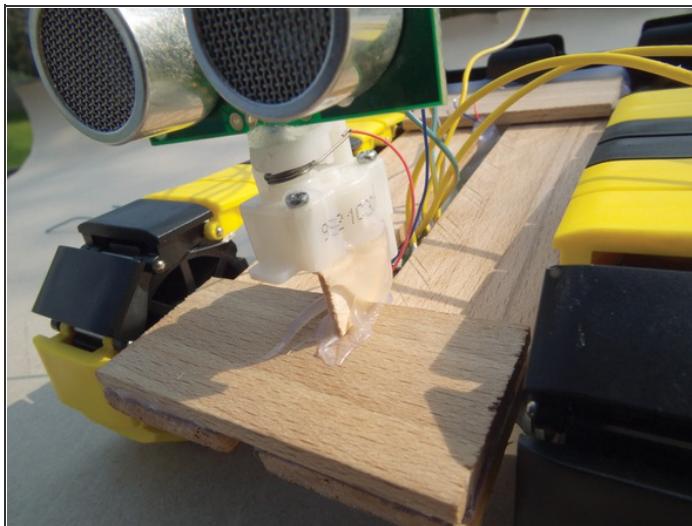
- Mount the battery holder to the rear end of the chassis like a rear bumper, using a line of hot glue.
- Test the sampler board with AA batteries to make sure it works (record your voice and play it back). Cut and strip one end of 2 female jumpers, then unsolder the sampler's mini speaker and replace its 2 original wires with the jumpers. Hot-glue the speaker under the chassis at the axle and run the jumpers topside.

Step 4 — Add the head and neck.



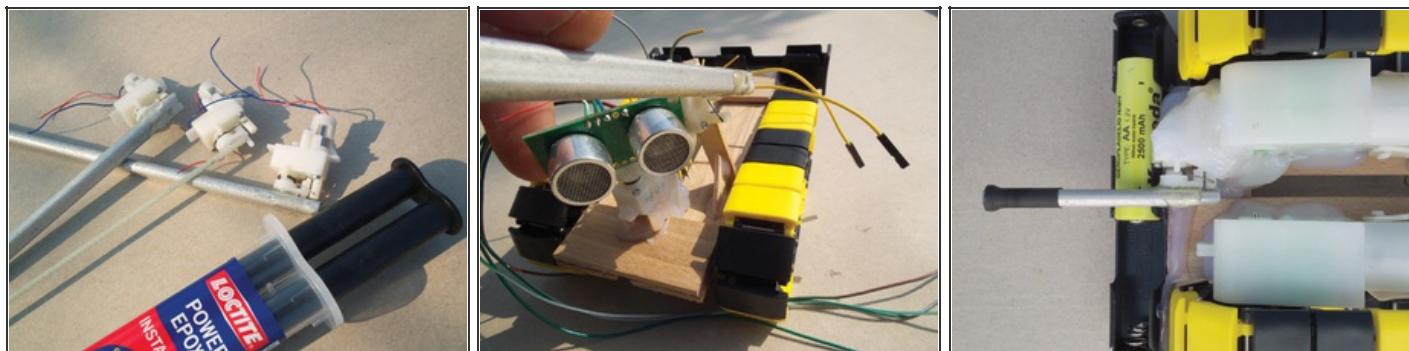
- Solder 4 insulated wires, each about 4" (10cm) long, to the back of the SRF05 rangefinder, to all but the fourth pad along the bottom. These are the board's 5V, Echo Output, Trigger Input, and Ground contacts.
- Epoxy the SRF05 "head" to a GM10 motor, perpendicular across the shaft and pointing away from the small pin sticking up, so the rangefinder can turn from side to side. During curing, I held the board and motor in place with putty and foam tape, but you can improvise another way.

Step 5



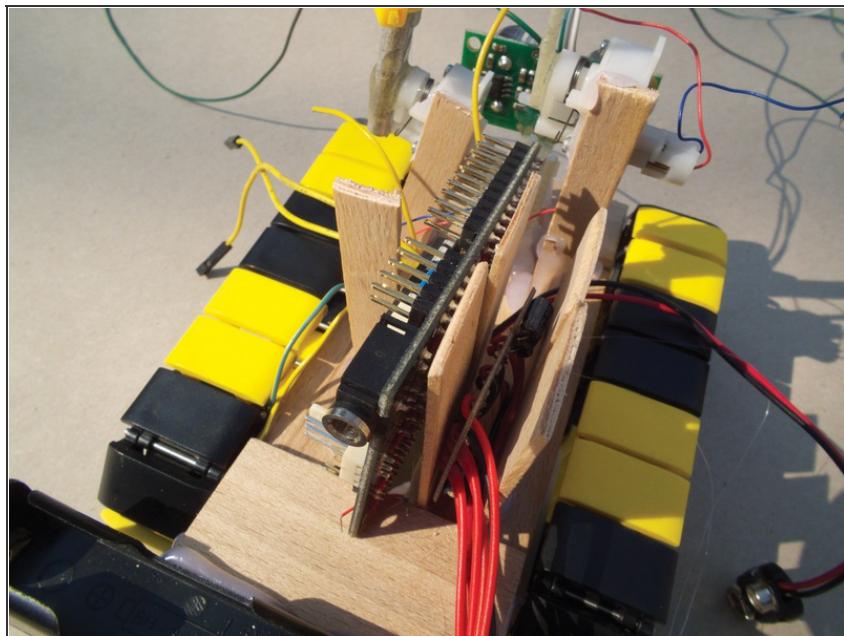
- Mount the “neck” motor at the front center of the chassis so that the head stands vertical (or leans only slightly forward; not as much as the chassis) and the rangefinder “eyes” sit back 5/64" or so (2mm) from the front edge. I used a bit of wood just under 1/2" (10mm) to prop the front of the motor to let it sit level, then added liberal amounts of hot glue to secure it to the chassis. Try to give the mount a small footprint.
- Turn the head from side to side. It should look straight ahead when not touched, and if it moves much more to one side than the other, glue fiberglass rods or wooden stops vertically so that it turns about equally far to the left and right.

Step 6 — Add the drumsticks.



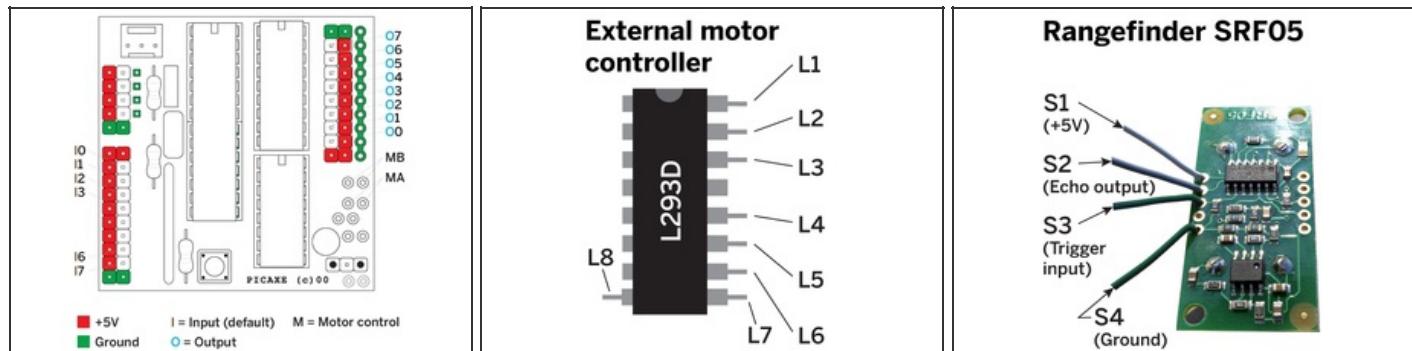
- The robot has 3 drumsticks, each of which is mounted to a GM10 motor: a bass drum “tail” under the battery pack, and thick snare and thin hi-hat drum sticks in front, held by motors attached to wooden uprights just above and behind the rangefinder “head” on either side.
- Estimate stick lengths by holding the motors in position and observing which way they’ll turn. The bass drum stick (about 2") should hit the ground at an 8 o'clock angle and the 2 front sticks (about 4" each) should be able to reach and drum on vertical surfaces 1" or so in front of the robot. Cut the sticks long, then trim them after seeing how they perform. Shorter sticks work better but look less cool, so you need to find a balance.
- Pre-mount each stick to its motor. Drill a hole through thicker sticks to fit over the pin, and tie thin sticks on with wire. Epoxy the sticks in place.
- Mount the motors to the chassis, eyeballing where you think they'll look good. For the front motors, I hot-glued wood uprights onto the chassis and added triangular reinforcements in front and back. (No, I'm not sponsored by a hot glue company.) Check that the sticks can travel freely with the head and other sticks in all possible rotational positions.

Step 7 — Mount the boards and large speaker.



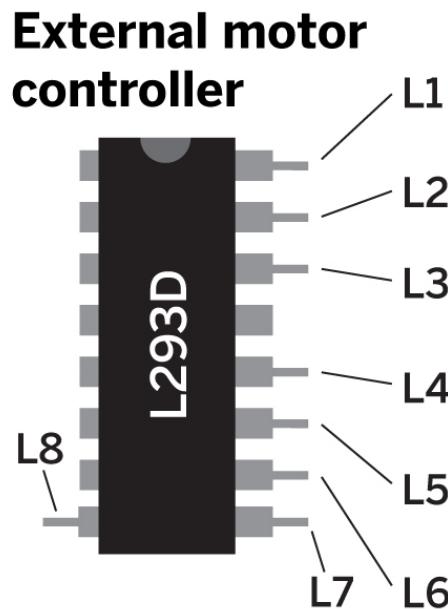
- To prepare the Picaxe board, plug one of the L293D motor controller chips into the onboard 16-pin socket, making sure the notch at one end of the chip matches the marking on the board. (Bend its pins to fit the socket by pressing the chip down sideways on a table.) This chip will control the track motors.
- Snap off and solder 2x2 male header pins into the 4 holes marked A and B on the board.
- It's time to mount the microcontroller, sampler, and larger, cool-looking speaker.
- Using more flat sticks and hot glue, I made 2 dividers running fore and aft along the right side to separate the microcontroller and sampler boards and hold them upright on edge. Note that the Picaxe board's programming jack needs to be easily accessible. On the sampler board, cut off the battery clip, but leave its wires connected to the board.
- Then I added a pillar on the left side and a roof to enclose the boards and support the large speaker on top, pointing up.

Step 8 — Wire the rangefinder, motors, and drumsticks



- Now let's wire everything up. The images in this step show the wiring points for the rangefinder, microcontroller board, and external motor controller chip (for the neck motor). Connect these components with wires, following the Connections list. (Save the sampler board for later, because you need to test it first to determine how it should connect.)
- You can connect voltage wires (V) to any +5V point, and ground wires (G) to any Ground point, whatever is closest or easiest. 
- Connect wires to the rangefinder and external chip by soldering and insulating with heat-shrink tubing. Make connections to the AXE20 board by plugging in female header wires. Make your own female headers by cutting female-to-female jumpers in half and soldering each half to a plain wire if more length is needed. (You can also connect ground wires to the AXE20 board via the solderable pads along one edge.)
- Connect the motors (tracks, drums, and neck) either way for now. You'll run test routines later and swap the 2 connections to any motors that run backward.

Step 9 — Connections.



- **Right and left track motors:** Connect to the onboard motor controller — left motor wires to the 2 MA pins on the main board, and right motor wires to the 2 MB pins. You'll swap pins later if motor direction is reversed.
- **Rangefinder:** S1 to +5V, S4 to Ground, S2 (Echo) to microcontroller I1, S3 (Pulse) to I0. The code converts pin I0 to an output, so it can trigger the pulse.
- **External motor controller:** L1, L7, and L8 to +5V, L4 to Ground, L2 to I6, L6 to I7. The code converts pins I6 and I7 into outputs.
- **Neck motor:** To external motor controller L3 and L5; swap them later if they're reversed.
- **Drum motors:** Snare drum motor to O1 and Ground, hi-hat motor to O2 and Ground, bass drum motor to O3 and Ground.
- **Small speaker (under chassis):** O0, Ground.

Step 10 — Wire the sampler board.

- You already cut off the sampler board's battery clip and speaker, but it still has a microphone, an LED, and Record and Play buttons connected by wire pairs. Mount female headers on the black and red wires that connected to the battery clip, then plug red onto a +5V pin on the main board and black onto a Ground. Mount the larger speaker on top of the robot, pointing up, and solder the 2 sampler board speaker wires to it.
- Insert batteries in your robot and test that the Record and Play buttons still work. Cut the Play wires close to the button and touch one of them to Ground on the main board. Does it play back? If so, this is the wire you'll need, and you can trim off the other one close to the board. If not, try the other. (With some samplers, you'll remove the Play button, test its pads on the circuit board, then solder a wire to the pad that works when connected to Ground.) Do the same with the Record button — find the wire that works when touched to Ground, and cut the other one away.
- Mount female headers to both wires, then connect the Record wire to I2 on the main board and the Play wire to I3.
- Mount the microphone and LED somewhere nice and visible. Now's the time to be creative with extra little decorative parts. (I found a shiny plastic ring that works well holding the microphone.) To tidy up, use cable ties and hot glue, and you can also shorten wire lengths.

Step 11 — Program, test, adjust, and play.

- At this point, you should have a nice little robot. Now it's time to give the robot its program. Download and install the Picaxe Programming Editor or AXEPad (depending on your computer OS) from [here](#), if you haven't already.
- Launch the software, then open the Mode and Ports tabs under the Options panel to specify the type of chip (28X1) and the COM port for your computer's USB.
- Switch the main board off (remove a battery) and connect it to your computer using the Picaxe programming cable. Download the code files [here](#).
- Each motor has a test code file in the test directory. Open each in the programming editor and click Program to compile and upload it to the microcontroller. Replace the battery and check that the motor behaves as it should, as described at the top of the test code, or swap its wires if it runs in the reverse direction.
- The test runs will also guide you in trimming the sticks to adjust their balance. The sticks should be light enough for the motors to move easily, but with fiberglass or carbon fiber rods, it might help to epoxy a small bolt or screw at the end, to make the strikes louder.

Step 12



- With all the motors tested and wired properly, compile and upload the final code, **ydm_default.bas**. Place the robot on a hard surface and power it up; it should look to the sides and begin driving around. After some time, it may feel it's time to get funky. It will then search for an appropriate item (like a wall) to drum on. Eventually, it will find an object it likes, then tap a little beat on it.
- The Yellow Drum Machine will record its drumming, then play it back in a loop while drumming more and making clicks from its lower speaker to the beat. Meanwhile, it also makes dance motions with its head and body.
- While the robot records itself, it will also record your voice or other nearby sounds and include them in its tune. This is especially entertaining for kids. Play a musical instrument to "jam" with the YDM, letting it record and play back your riffs as an accompanist.
- The BASIC software is written for modifying and playing. All parameters can be reset, and notes at the top and comments throughout explain how everything works. So you can make the YDM drum only when you enter the room, or use it as a platform to do a lot of other things. You can even make it draw.

Frits Lyneborg is co-host of ["The Latest In Hobby Robotics"](#) and runs <http://www.letsmakerobots.com>, the largest online community of its kind, which he started in 2008 as a forum for robot electronics, programming, and funny ideas and inspiration.

This project first appeared in [MAKE Volume 27, page 42.](#)

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